



## What makes car users adopt an environmentally friendly driving style?

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Road traffic noise has considerable negative health, social and economic impacts. Apart from technical improvements, targeting the behavior of individual drivers is a further strategy to reduce noise. However, a sound theoretical foundation upon which to design individual-based interventions is needed. This contribution deals with the psychological factors that make car users adopt a low-noise driving style ('eco-driving'). The study reported was set up to gain insight into the possible psychological factors that explain an individual's willingness to try eco-driving. The starting point of the study was a theory-based stage model of voluntary behavior change. By means of qualitative interviews, stage-specific predictors of the model were identified that could predict whether or not individuals would change their driving style. The model was quantitatively tested by a survey (N > 800). First results from this survey are presented and discussed. Questions addressed are whether the data support the hypothesized model, and which psychological factors best explain the intention to try and the self-reported application of eco-driving.

## 1 INTRODUCTION

More than 1.2 million people in Switzerland (about 15% of its population) suffer from road traffic noise exceeding the threshold limits. In addition to road traffic, many everyday activities

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are a source of noise. Thus it is the individual who creates noise and at the same time suffers its effects. The Swiss government's strategy of noise abatement focuses on reducing noise pollution at its sources, which means that – aside from technical improvements and land-use regulations – measures of awareness building and promoting behavior change are taken. Until recently most of these measures consisted in delivering information about the extent of noise pollution and the health risks from excessive noise stress. Presumably, the potential of noise reduction by promoting low-noise behavior has not yet been realized – not least because a sound theoretical base upon which to design effective interventions is largely missing. A research program funded by the Swiss Federal Office for the Environment aims to fill this gap. It has the double objective of (1) constructing a robust theoretical model of the psychological, social and situational factors relevant for changing specific noise-producing behaviors and (2) designing – based on this model – promising interventions for promoting desirable low-noise behaviors. This paper introduces the general model and shows how it has been empirically tested for the specific case of 'eco-driving', which is a low-noise and fuel-saving driving style that has been much promoted in the past years in Switzerland.

## **2 WHAT IS 'ECO-DRIVING'?**

'Eco-driving' is a driving style characterized in the main by four "golden rules":

- Use the highest possible gear and drive at low engine speed/revolutions
- Accelerate swiftly
- Shift up early and shift down late
- Drive with foresight and smoothly, avoid unnecessary stop and go and gear-shifting maneuvers

Such a driving style has several benefits: less noise pollution (the engine noise of one car running with 4000 rev/min is equal to the noise produced by 20 cars running with 2000 rev/min); less fuel consumption and thus less CO<sub>2</sub> emissions (-10%); less stress from frequent accelerating and braking; more safety due to driving with foresight; lower wear. For these reasons using eco-drive is one of the specific behaviors individuals can choose in order to contribute to a reduction of traffic noise. In Switzerland, eco-driving has been propagated quite heavily for about ten years, and special training courses are being offered<sup>1</sup>. From the perspective of noise abatement it would be desirable if this driving style became common practice among car drivers.

Therefore, the question for this study is: What makes car users adopt a low-noise and environmentally friendly driving style ('eco-drive')?

## **3 METHODS**

### **3.1 Developing the Model**

A literature search in the field of social, health, and environmental psychology was conducted. Three groups of theories were reviewed. First, motivational models such as the Theory of Planned Behavior<sup>2</sup>, the Norm Activation Model<sup>3</sup>, the Value-Belief-Norm Model<sup>4</sup>, the Social Cognitive Theory<sup>5</sup>, the Protection Motivation Theory<sup>6</sup>, and the Social Psychological Model of Noise Annoyance<sup>7</sup> were examined. These models focus on the behavior intention and assume that intention leads, more or less directly, to the intended behavior. Second, behavioral enaction models such as the Implementation Intention Theory<sup>8</sup> and Goal-Theory<sup>9</sup> were analyzed. In these models, the focus is on the transition from intention to behavior. Third, multi-stage models for explaining behavior change were analyzed. The authors of these models focus on

behavior change as a process of going through different stages. They address the fact that individuals show different behaviors and are susceptible to different kinds of information depending on the stage they are in. The following multistage models were analyzed: the Health Action Approach<sup>10</sup>, the Rubicon Model<sup>11</sup>, the Transtheoretical Model<sup>12</sup>, and the Precaution Adoption Process Model<sup>13</sup>. The Transtheoretical Model (TTM)<sup>12</sup>, originally developed to explain behavior change in health contexts, was chosen as a basis. It includes most of the stages emphasized by the other multistage models mentioned above. Based on this thorough examination of existing theoretical approaches a generic model of voluntary behavior change was constructed. In a next step, a number of qualitative interviews with experts of noise abatement and noise prevention as well as with car drivers, motorcyclists and experts of eco-driving and car servicing were conducted. These interviews were used to specify the generic model for the context of road traffic noise, i.e. relevant behaviors were identified (such as driving style and purchase of tires) and the elements of the model were specified with respect to these behaviors.

### 3.2 Testing the Model

The model was tested by means of an online-survey with two measurements four months apart. The survey questions were designed to operationalize the model variables as well as the personal attributes that are potential predictors of successful progress through the stages of behavior change. 1684 persons (aged 19-80 years, 53% male, 47% female) produced valid responses at the first measurement point (October 2011 through January 2012). In this paper results of the subgroup of car-drivers (i.e., persons who drive a car at least once a month), who were asked questions related to eco-driving, are reported (n=890).

## 3 RESULTS

### 3.1 The Model

Figure 1 is an outline of the generic model of behavior change. In line with existing theories we assume that voluntarily changing a well-established behavior (such as driving a car) is a process, within which several stages can be distinguished: A person who is initially carefree with respect to the behavior (i.e., she is not aware of any problematic effects of her current behavior and/or does not see any necessity of change) will – according to our model – go through *five stages* until a new behavior is established and maintained. For the example of traffic noise and the desired behavior eco-driving, the stages can briefly be described as follows:

- Goal-selection stage: In this stage, a person proceeds from a state of carefreeness to the belief, that traffic noise is a problem and that she has a certain responsibility to contribute to reducing it. Thus she forms the goal to avoid road traffic noise.
- Behavior-selection stage: In this stage, a person finds out by what behaviors she can contribute to less traffic noise, e.g., by eco-driving, and what behavior(s) suit her best. If she doesn't find a behavior she is willing and able to perform, she falls back to the previous stage; she might reappraise her goal.
- Planning stage: If the person has decided to perform a specific new behavior (e.g., eco-driving), she starts to plan how to realize it (e.g., she gathers information about how to perform eco-driving, and she anticipates a specific occasion for trying it).
- Implementation stage: in this stage the person begins to perform eco-driving.

- Evaluation stage: in this stage the person reflects and evaluates her experiences with the new driving style and its perceived effects. If the evaluation is positive, she will continue to apply eco-driving and eventually the new driving style will be maintained and become a new routine.

The model further states that a person may not go through the stages in a linear and direct way but that it is possible *to fall back in an earlier stage* at any point in the process (indicated by the downward flashes in Figure 1). Within the different stages specific psychological (cognitive and motivational-emotional) processes with respect to the problem situation and the current and possible alternative behaviors take place. These processes are influenced by attributes of the person (age, gender, living situation, etc.) as well as by the different aspects of the broader societal context.

We assume that the transitions between the stages are marked by specific *transition variables*, i.e., these variables serve as indicators of the different stages:

- The goal intention to avoid road traffic noise marks the transition from the goal-selection to the behavior-selection stage (e.g., „I have the goal to avoid road traffic noise“).
- The behavior intention to perform eco-driving marks the transition from the behavior-selection to the planning stage (e.g. “I intend to perform eco-driving”).
- An implementation intention marks the transition from the planning to the implementation stage (e.g., “I know when, where, and why I will perform eco-driving”).
- The initiation of the selected new behavior marks the transition from the implementation to the evaluation stage (e.g., “I have performed eco-driving at least once”).
- Repeating/maintaining the new driving style indicates that the behavior change process is completed (e.g., “Every time that I drive a car I apply eco-driving”).

### 3.2 Empirical Tests of the Model

The structure of the model, i.e., the succession of the different stages (as indicated by the transition variables) was tested by calculating Structural Equation Models on the survey data<sup>g)</sup>. Confirmatory factor analysis, mediator tests, and a test of the entire succession of the transition variables were performed. The tests clearly indicate that (a) all transition variables can empirically be distinguished in different variables, (b) implementation intention mediates only partially between behavior intention and initiation of the behavior, i.e., behavior intention has also a direct effect on the initiation of the behavior (see Figure 2).

### 3.3 Predictors of Successful Behavior Change

The psychological processes within the stages are a complex interplay of different factors that are well-defined theoretical constructs in the approaches that we have examined<sup>2-9</sup> or were derived from the qualitative interviews. Several factors were covered in the survey, because they can serve as predictors for the progress through the stages of behavior change. According to our model we would expect that depending on the stage, different factors are relevant. First regression analyses seem to confirm this general hypothesis:

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<sup>g)</sup> Structural equation modeling is a statistical technique, which combines measurement models and structural models in one calculation. Within the measurement models latent variables are deduced from measures by factor analysis. Within the structural models the structure between the latent variables is tested (e.g., by correlations or regressions).

- Major predictors of the transition variable *goal intention* are: personal norm related to noise, personal responsibility, biospheric value orientation, and age.
- Major predictors of the transition variable *behavior intention* are: attitude towards eco-driving, current driving style, personal norm related to eco-driving, and descriptive social norm related to the behavior.
- Major predictors of the transition variable *implementation intention* are: behavior intention, knowledge of alternative behaviors, current driving style, coping with implementation difficulties, and age.

The analysis of the second measurement point of the survey will shed light on the prediction of *initiation* and *repetition* of the new behavior.

### 3.4 Is Eco-Driving already Common Practice?

The survey contained key questions that were used to determine in which stage the persons were with respect to eco-driving. More than 80% said that they had already applied eco-driving and that they will stick to it in the future. This seems to indicate that the majority of car-drivers is in the state of behavior repetition, i.e., that eco-driving is already prevalent among car-drivers. However, when asked in detail how often they practiced the various elements (“golden rules”) of eco-driving, the picture is rather mixed: some crucial elements (especially swift acceleration/rapid shifting up and not shifting down early when driving uphill) seem not to be practiced very often. Also, the correlations between the correct application score and the variables initiation and repetition of the behavior are, although significant, rather low ( $r = 0.237$  and  $0.337$ , respectively).

## 4 DISCUSSION AND CONCLUSIONS

The generic model of voluntary behavior change that was developed in this project can be applied and specified for different domains and behaviors and thus provides a suitable theoretical basis for designing individual-based interventions in order to promote desirable behavior change. We have successfully specified the model for the domain of road traffic noise and the individual behavior eco-driving as a low-noise (and fuel-saving as well as safe) driving style. An online-survey provided a first empirical confirmation of the model structure as a whole, although a minor revision with respect to the planning stage might be necessary, at least for highly automatized routine behaviors as the driving style.

The results further indicate that the majority of the survey participants knows about eco-driving and seems to have already adopted this driving style. However, people seem not to know very precisely what eco-driving means besides using a high gear in urban traffic and letting the car roll out when approaching a red light. This means that many people do not perform eco-driving correctly and thus the potential in terms of noise reduction and fuel saving is probably not fully realized.

Therefore, we can already conclude that there is no need for interventions that focus on informing people in a general way about eco-driving and convincing them of its benefits. Interventions should rather aim at improving precise knowledge and correct application of this driving style. The analysis of the second measurement of our survey will provide more information about the crucial factors that predict the initiation and maintenance of the behavior.

## 5 ACKNOWLEDGEMENTS

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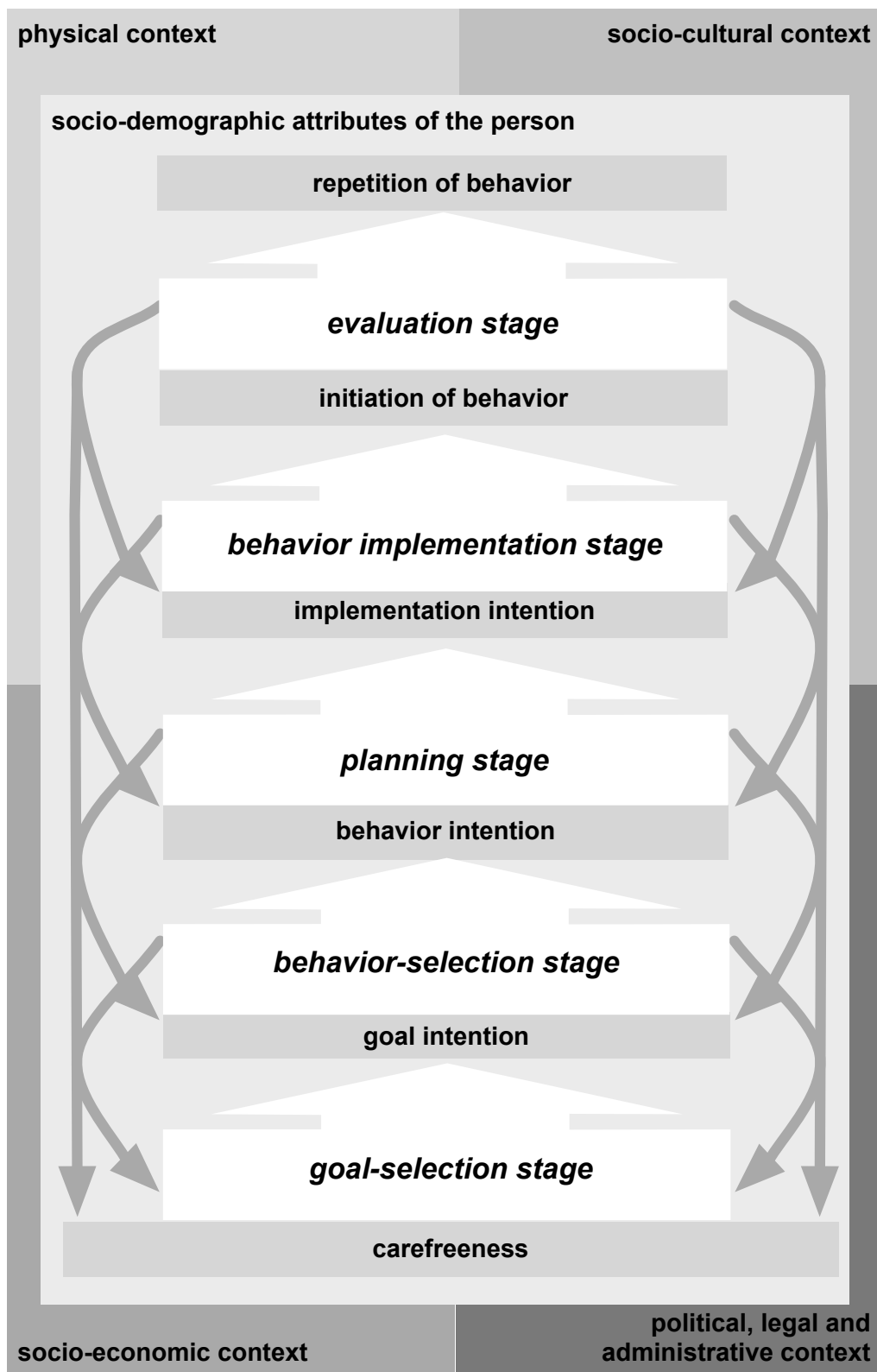


Fig. 1 – Generic stage model of voluntary behavior change, with transition variables.

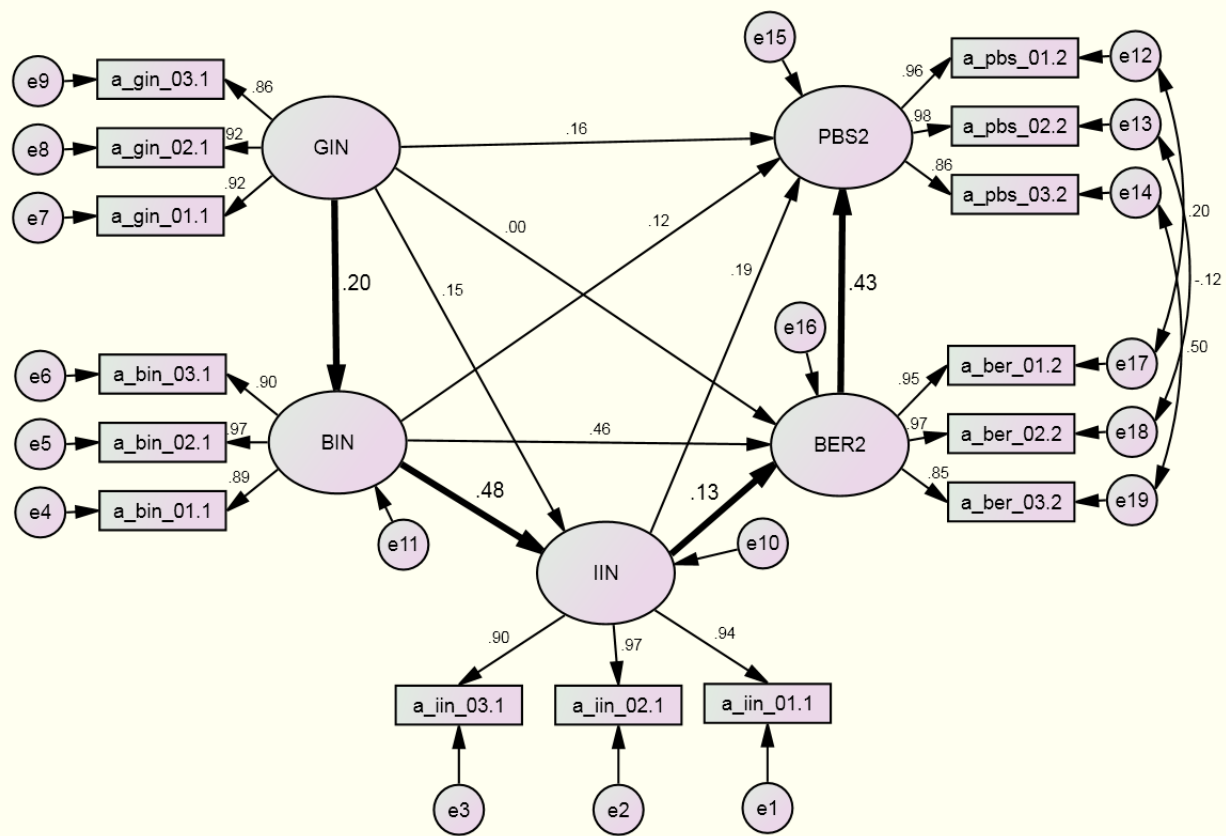


Fig. 2 – Result of the empirical test of the model structure. GIN goal intention to avoid road traffic noise, BIN behavior intention to perform eco-driving, IIN implementation intention to perform eco-driving, BER initiation of performing eco-driving, PBS repeated performance of eco-driving (BER and PBS were measured at the second measurement point). Fit indices:  $N=890$  Chi-Square: 209.207,  $df = 77$ ,  $p = .000$ , CFI = .99, RMSEA = .031 (.026-.036).